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A Southern California Gas Company Project Sage Report

Public Policy Issues

(NASA-CR-155945) PUBLIC POLICY ISSUES. A
SOUTHERN CALIFORNIA GAS COMPANY PROJECT SAGE
REPORT (Jet Propulsion Lab.) 24 p
HC A02/MF A01

CSSL 10B

N78-19613

Unclas
G3/44 08638

Prepared for
Southern California Gas Company
by
Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California



1. Report No. JPL Pub. 77-47	2. Government Accession No.	3. Recipient's Catalog No.	
4. Title and Subtitle Public Policy Issues A So. Calif. Gas Co. Project SAGE Report		5. Report Date January 1978	
		6. Performing Organization Code	
7. Author(s) R. Barbieri/A. Hirshberg		8. Performing Organization Report No.	
9. Performing Organization Name and Address JET PROPULSION LABORATORY California Institute of Technology 4800 Oak Grove Drive Pasadena, California 91103		10. Work Unit No.	
		11. Contract or Grant No. NAS 7-100	
12. Sponsoring Agency Name and Address NATIONAL AERONAUTICS AND SPACE ADMINISTRATION Washington, D.C. 20546		13. Type of Report and Period Covered JPL Publication	
		14. Sponsoring Agency Code	
15. Supplementary Notes			
16. Abstract <p>This report recognizes that use of solar energy to stretch our supplies of fossil fuels is to this Nations' benefit. Project SAGE, sponsored in part by the Southern California Gas Company addresses itself to one application of this goal: solar assistance in central water heating systems for multifamily projects.</p> <p>Public policy issues that can affect the rate of adoption of solar energy systems are investigated and policy actions are offered to accelerate the adoption of SAGE and other solar energy systems.</p>			
17. Key Words (Selected by Author(s)) Law and Political Science General (Other)		18. Distribution Statement Unlimited - Unclassified	
19. Security Classif. (of this report) Unclassified	20. Security Classif. (of this page) Unclassified	21. No. of Pages 23	22. Price

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January 1978

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California Institute of Technology, for the Southern
California Gas Company.

NOTICE

This report describes the results of one phase of research sponsored by the Southern California Gas Company. The research was made possible by grant number PTP75-03457 from the National Science Foundation to the Southern California Gas Company. Any opinions, findings, conclusions or recommendations expressed in this publication are those of the authors and do not necessarily reflect the views of the Southern California Gas Company.

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FOREWORD

This report covers work done in late 1974 through 1976. It is submitted as part of the formal documentation of Project SAGE. The reader should recognize that much work has been done since the end of the period covered, and that the results presented here do not reflect that additional work. For further information regarding this report, please contact R. E. Bartera, at Jet Propulsion Laboratory, 4800 Oak Grove Drive, Pasadena, California, 91103.

ABSTRACT

This report recognizes that use of solar energy to stretch our supplies of fossil fuels is to this Nations' benefit. Project SAGE, sponsored in part by the Southern California Gas Company addresses itself to one application of this goal: solar assistance in central water heating systems for multifamily projects.

Public policy issues that can affect the rate of adoption of solar energy systems are investigated and policy actions are offered to accelerate the adoption of SAGE and other solar energy systems.

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SECTION I

INTRODUCTION

It is in the national interest to promote the use of solar energy as a means of stretching our supplies of valuable fossil fuels. Project SAGE, developed in recognition of this goal, addresses one application of solar energy: central water heating systems for multifamily projects. Sponsored in part by the Southern California Gas Company, the project investigates specifically the potential for such systems in that company's service territory. Nevertheless, its findings may be applicable to other solar energy uses and to other geographic areas. Certainly the public policy issues considered in this report are of general application.

Public policies can affect the rate of adoption of solar energy systems both positively and negatively. This report examines both kinds of effects and suggests certain specific policy actions that may serve to accelerate the adoption of SAGE and other solar energy systems.

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SECTION II

BARRIERS TO THE ADOPTION OF SOLAR ENERGY SYSTEMS

The barriers that presently tend to limit the adoption of solar energy systems can be classified as technical, economic, and institutional. In the case of SAGE systems, the technical barriers are few and are discussed elsewhere. The economic barriers to be discussed are:

- (1) Gas and electric rate regulation policies
- (2) High first cost of solar energy systems
- (3) Unfamiliarity of lenders with solar energy systems
- (4) Property tax treatment of solar energy systems
- (5) Financial risk perceived by builders in incorporating solar energy systems

Institutional barriers (not always clearly separable from economic barriers) to be discussed are:

- (1) The fragmented nature of the building industry
- (2) The associated "information cost" of acquiring a new technology
- (3) Inertia on the part of the building industry and the general public
- (4) Potential legal obstacles in the form of building codes and deed restrictions
- (5) The uncertain status of "sun rights" of property owners.

Solar water heating is a simple and efficient application for solar energy, and can be shown to be economically competitive on a life-cycle cost basis with electricity and with the more expensive proposed techniques for producing synthetic natural gas. The competitive picture is clouded, however, by the current regulatory policies for natural gas pricing which generally require average or "rolled-in" pricing of gas rather than a price that reflects the marginal cost of new gas supplies.

The net result is that the average "rational consumer" compares the costs of solar and conventional water heating systems and finds that the conventional system is the best bargain. He may reach this conclusion even if he uses life-cycle costs that compensate for the higher initial cost of solar installations with the lower operating costs. If this analysis shows little difference, he is likely to opt for the conventional system because of the uncertainties associated with a 15- to 20-year payback period. Gas price increases may be seen as inevitable,

but the amount and timing of the increases are not predictable. In the case of apartment building owners, the increases can be passed along to tenants when they occur, while the cost of the solar installation must be incorporated in rent charges from the beginning.

Solar installations will always have a higher first cost, but the calculation of payback period depends on the cost of the alternative. If gas is priced at the cost of new gas supplies, the payback period for the solar system will be shorter and it will therefore be more attractive. As an example, some new natural gas supplies such as gasified coal or imported liquefied natural gas are projected to cost up to \$5 per thousand ft³. This translates into \$10 per million Btu delivered to the consumer (for distribution charges of \$1 per thousand ft³ and 60% efficient usage). The cost of solar water heating delivered to the consumer is about \$8 per million Btu (with an 8% loan and 20-year life). On this basis the rational consumer would choose solar water heating, but this is not the basis of choice at present because of the regulation of natural gas prices.

Using the same figures for "rolled-in" gas pricing and assuming that 5% of the gas supply is from a "new" high-cost source, we find the consumer paying \$2.85 per million Btu (with existing supplies at \$1.50 per mcf and calculating the price of 100 mcf on the rolled-in basis). Thus even with widely varying assumptions, gas priced on a rolled-in basis will almost certainly appear a better bargain than solar water heating. This pricing policy essentially insulates the consumer from the true cost of new gas supplies and constitutes an unfair but effective barrier to the adoption of solar water heating.

The high first-cost of solar installations generally implies loan financing of such installations. This leads to another economic barrier, since lenders are unfamiliar with solar energy systems. They have not had enough experience to permit a sound assessment of the risk, with the result that they are reluctant to make such loans.

The tax treatment of solar equipment can also be an economic barrier. Solar water heating equipment for example is much more expensive than conventional water heating devices, and if this added cost is included in the value of the building, the property taxes will be higher accordingly. The tax laws have no provisions for reflecting life-cycle costs, and such tax treatment can serve as an added disincentive to potential purchasers of solar systems.

Other barriers to widespread adoption of solar energy systems are classed as institutional barriers. The natural tendency to avoid risk is in part an institutional barrier and in part, as noted above, an economic one. Developers and builders must avoid risk whenever they can, since they are working with borrowed funds and schedule delays can produce large losses. Frequently they will not even consider using innovations that reduce first cost (much less life-cycle costs); they prefer to stay with technologies that they know will work and let others

do the pioneering. In effect, each builder has an incentive to let some other builder adopt solar energy first, with the result that there are long delays in the use of even the best innovations.

A major institutional barrier to rapid adoption of new technologies such as solar energy systems is related to the nature of the construction industry. It is a highly fragmented and regional industry, with no dominant, large-scale producers such as are common in other industries. Of the 300,000 builders in the United States, 90% produce less than 100 units per year and the largest produces less than 1% of the annual total. There is a high degree of horizontal stratification; any given construction project is actually implemented by a dozen or more individual subcontractors or suppliers, from the architect to the lathing subcontractor, each of whom is autonomous and not a part of the builder's organization.

All of these vertical and horizontal elements of the construction industry have, over the years, evolved a satisfactory and generally efficient way of working, but few of their procedures are formal or written. They are comparable to a body of unwritten laws or customs. This type of organization inherently has a large amount of inertia and resistance to innovation and new technologies are adopted only gradually.

Part of the reason for this inertia is the "information cost" of adopting new technologies. Information on commonly used types of equipment is widely available, generally in the form of manufacturers' or suppliers' catalogs and specification sheets, handbooks, and similar reference material. There is a cost at every level for building this kind of information base for a new technology, plus a cost associated with the process of familiarization. In a highly competitive industry like construction, there is a tendency to avoid these information costs as long as possible, in the hope that they will be incurred by some other element of the industry.

In addition to the inertia inherent in the construction industry, there is a similar inertia on the part of the general public. Individuals tend to prefer to wait until others have gone first, thereby reducing the perceived risk associated with a new technology. Studies by Griliches, Mansfield, Hagerstrand and others (References 2-1, - 2-3), have yielded analytical models of the adoption process. Methods have been developed for estimating the time lag between invention and innovation (the first application of an invention), but the results are quite sensitive to the assumptions made. Mansfield (Reference 2-2), for example, identifies four principal factors that seem to govern the rate of innovation: 1) its economic advantage; 2) the uncertainty of realizing that advantage; 3) the required investment; and 4) the rate of reduction of the initial uncertainty.

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Another study examines the differences in the willingness of people to try a new product or service. Rogers and Shoemaker (Reference 2-4) developed a classification scheme based on this characteristic of "innovativeness" of consumers. Adopters are divided into five categories:

- (1) Innovators (the first 2.5%)
- (2) Early adopters (the next 13.5%)
- (3) Early majority (the next 34%)
- (4) Late majority (the next 34%)
- (5) Laggards (the last 16%)

Naturally these schemes include economic as well as cultural factors. Mansfield's two economic criteria are payback period and size of initial investment. In general, customers require relatively stringent payback criteria before buying a new product. A 10-year payback period seems reasonable for an early adopter, and a 5-7 year period for the early majority or a 3-year period for the late majority. The innovators and the laggards are probably not classifiable on the basis of payback period, since their decisions are based on more complex personal variables. Although these figures are intended to be general in their application to any new product or service, they may also be applicable to home buyers or builder/developers. The turnover rate of homes is such that few buyers retain ownership for periods much greater than those indicated, and builder/developers of apartment buildings frequently do not plan on retaining ownership for the 20 years assumed in most life-cycle cost analyses.

Another category of institutional barriers consists of legal questions. There is considerable uncertainty at present as to how solar energy systems will be treated in building codes, since few codes have any provisions for such systems. Also, there are in many areas deed restrictions (known as covenants, conditions, and restrictions) that limit choices of architectural features. Where solar collectors are incorporated in the architecture (especially in retrofit installations), these provisions may limit their adoption.

A final legal issue that is causing concern is that of "sun rights." The right of property owners to have access to sunlight is not guaranteed under existing laws and precedents, although there have been some initial efforts in this direction. This factor can add to the uncertainties associated with solar energy systems, although its effect is not clear at present. One opinion (T. Thomas of the American Bar Association) is that continued uncertainty regarding sun rights could eventually pose serious difficulties for the use of solar energy.

Two states have addressed this problem. A 1975 Oregon law requires that access to solar energy be considered in land use plans, specifically with respect to height and setback requirements. Colorado has given solar easement legal standing in that state. Other proposals are for a transferable solar right (Harris of the Rand Corporation) and three-dimensional zoning (Schoen and Hirshberg, JPL). Until more experience has been gained, there is no obvious choice among the proposals.

SECTION III

POLICIES TO REDUCE BARRIERS TO THE ADOPTION OF
SOLAR ENERGY

Public policies can have the effect of reducing many of the barriers to adoption of solar energy systems. This section will review the policies that have been suggested or implemented to achieve this result.

As noted, public policies do not in general affect the technical issues of solar energy; a major exception is the extensive program of research, development, and demonstration being carried on by the federal government. The results of this program can be expected not only to provide needed technical advancements and information, but to influence many of the economic and institutional decisions affecting the rate of adoption of solar energy systems.

Current gas pricing policies, particularly the requirement for rolled-in pricing of new natural gas supplies, have been identified as distorting the competitive economics of solar versus gas heating. This requirement is the result of public policies, and the simplest means of eliminating the distortion would be to deregulate gas prices completely. Alternately, utilities could be allowed to price gas at the marginal cost of new gas supplies. Either change would result in a rapid rise in the cost of gas and is probably not politically feasible. In addition, such a policy adopted in one state could have negative economic effects. If California, for example, adopted a pricing policy that reflected the realistic cost of gas it would probably lose industry and jobs to states that maintained the current policy. Current federal initiatives may eliminate this problem and at the same time allow gas prices to rise, gradually, to a more realistic level.

Another policy that has been suggested would require that the environmental costs associated with the use of fossil fuels be incorporated in their prices. These are real "social" costs that are not now reflected in the prices of fossil fuels and further distort the comparison with solar energy (which has little or no effect on the environment). Mechanisms for incorporating these environmental costs have been proposed (Reference 3-1), but implementation would probably be difficult. In any case, natural gas has less affect on the environment than do other fossil fuels and prices might not be significantly affected.

The problems associated with life-cycle costing, particularly the reluctance of decision makers to base their decisions on this type of analysis, have been mentioned. It has been suggested that builders might be required to make such an analysis and to select the system with the lowest life-cycle costs. The advantage would be that solar energy would not be required where it was not feasible or economically sound; the disadvantage is that such a policy would meet with resistance and could easily be circumvented by appropriate manipulation of the figures.

The reluctance of lenders to make loans on solar equipment is based, as previously noted, on the lack of a basis of experience with such equipment. Those policies which lead to the acquisition of more operating experience with solar systems and to the dissemination of the results of that experience should help to reduce this barrier. These policies are discussed later.

It has been proposed that the disadvantage of solar energy systems with respect to property taxes could be eliminated by providing a tax exemption for such systems. While the actual amount of the incentive would probably not swing a decision, its existence would indicate a recognition on the part of legislators that the use of solar energy is in the public interest. Associated revenue loss would not be significant, and it appears that this type of incentive should be easy to adopt.

Several types of financial incentives are frequently suggested to reduce the first-cost disadvantage of solar systems. Reducing the first cost can make solar systems more economically competitive with conventional systems without the requirement for life-cycle costing and unacceptably long payback periods. The tax incentives that have been proposed (over 100 pieces of legislation to promote solar energy have been introduced in 32 state legislatures) are tax abatements, tax credits, and low-interest loans.

The property tax exemption affects the continuing cost more than the initial cost. The other type of tax abatement proposed is the exemption of solar equipment from state sales tax. The first-cost reduction of 6% (in California) would probably not be a determining factor, but would provide some encouragement and again indicate the interest of the legislature in promoting the use of solar energy.

Tax credits are a more significant factor affecting the initial cost of solar systems. Those proposed usually provide for a direct reduction of income tax up to some percentage of the total initial investment in a solar system, with a maximum dollar ceiling. For business firms, the incentive may be in the form of accelerated depreciation. A typical bill, HR 6860 of 1975, allowed a reduction of income tax by 25% of the cost of a solar system, with a maximum deduction of \$2000. Commercial builders could choose either an investment tax credit of 10% or a 5-year depreciation schedule.

Tax incentives are generally intended to speed the rate of adoption of solar energy systems to the point where mass production is possible, with resulting sharply lower costs. For this reason, they usually have an expiration date; the bill mentioned previously had a scheduled expiration date of January 1, 1981.

Low-interest loans provide for public subsidy of the difference between the prevailing interest rate and a lower rate which would make solar systems more attractive. In the case of a 20-year loan, a 5% rate

will produce an equivalent first-cost reduction of about 30% if the prevailing rate is 8%, and 50% if the prevailing rate is 10%. These are large enough incentives to influence a decision to adopt solar energy.

Certain problems should be taken into account in evaluating policy incentives to the adoption of solar energy. First, although it seems to be generally agreed that "solar energy is good," it is not clear how its advantages can be weighed in dollar terms. Its environmental advantages are not well quantified, and the factor of reducing dependence on foreign oil also has a value difficult to establish in dollar terms at the individual and local levels. A state legislature can hardly justify a large revenue loss on this basis.

Secondly, strong incentives will distort the marketplace and reduce the incentive for improving solar technology. Also, it is not wise public policy to encourage the use of any energy system that is more costly than the alternatives and may not work as well as expected.

Third, the incentive itself might slow down the adoption of the technology making people wait for the enactment of incentive legislation when they might otherwise have invested in a solar system, particularly since the legislative process is typically long. Retroactive provisions in proposed legislation could help eliminate this disincentive.

Most of the institutional barriers discussed in the previous section are associated in some way with the scarcity of information on the real performance and cost characteristics of solar energy systems. Generating and disseminating such information would be an effective means of reducing those barriers. In particular, the actual or perceived risk that deters lenders, the construction industry, and individuals is a natural result of the uncertainties consequent on this lack of information. The "information cost" incurred by members of the construction industry could be reduced by an active program of disseminating appropriate technical and performance data in forms customarily used in the industry.

The federal program (primarily ERDA) of solar energy research, development, and demonstration is a continuing source of the kinds of information that are needed. It has not yet developed answers to all the questions that must be answered before solar energy reaches full commercial status, but it is moving toward that goal. Results of the demonstration programs are of particular importance in the context considered here. Similar demonstrations are being carried out by other agencies and by individual utilities. In all cases, the results are of value only when they have reached those who can put them into commercial practice.

Information dissemination policies are of two types: active and passive. Passive methods are generally data banks or clearinghouses that collect the information and make it available. Active methods take action to provide the information to potential users. The drawback of passive methods is that those who need the information must know that the data source exists, what it contains, and how to obtain and use it.

Active dissemination of solar energy information will probably require some intermediary between the sources of information and the users to help translate solar energy technical information into terms that are understandable to builders, subcontractors, and potential users. There is also a need to monitor and report problems that users encounter in their application of solar energy and provide these reports to members of the solar technology community to guide their continuing research and development efforts.

The concept of such an intermediary, combined with a capability for independent project evaluation and policy analysis, has been investigated by the author under a grant from the National Science Foundation. In that study it was characterized as an Implementation Center, with the objective of reducing the real and perceived risks associated with solar energy installations (Reference 3-2).

The effect of such an active dissemination program would be to reduce both the risk factor slowing the adoption of solar energy and the information costs incurred by builders and subcontractors undertaking solar energy installations.

Potential legal restraints on solar energy in the form of building code provisions and deed restrictions are not expected to be a major impediment in the long run, but may cause local problems for a time before solar energy technology becomes incorporated into normal architectural and building practice. The sun rights issue may be troublesome in individual cases until legal precedents are established to regulate this aspect of solar energy.

Table 3-1 summarizes the above discussion of possible policies and their effects on the development of solar energy systems.

Table 3-1. Policy Options Which Reduce Industry Barriers to the Use of Solar Energy

Barrier to Industry Response	Policy Option	Possible Positive Effect	Possible Disadvantage
1. First-Cost Sensitive	<p>A. Deregulation of domestic fossil fuels</p> <p>B. Require life-cycle costing</p> <p>C. Financial incentives</p> <ol style="list-style-type: none"> 1. Tax abatement 2. Tax credit 3. Low interest loans 	<p>Improve solar energy cost competitiveness</p> <p>Eliminates first-cost as only criterion for HVAC selection</p> <p>Reduced direct-cost, provides a direct incentive for use of solar energy systems</p>	<p>Consumer resistance and therefore political problems</p> <p>Difficult to implement; possible hidden resistances.</p> <p>Easy to manipulate</p> <p>May produce less efficient solar energy systems</p>
2. Information-Cost Sensitive	<p>A. Clearinghouse or data bank/special purpose library</p> <p>B. Active dissemination (Implementation Center)</p>	<p>Provides a central place for development to get information</p> <p>Provides necessary information and in the proper form so that it can be understood by the user</p>	<p>Does not help user translate information into usable form</p> <p>Expensive and requires public advocate</p>
3. Risk-Aversion	<p>A. Demonstration program</p> <p>B. Institutional Actions (Implementation Center)</p>	<p>Provides direct evidence of the feasibility of solar energy, if done properly</p> <p>Paves way for the elimination of certain critical barriers such as codes</p>	<p>May not be done in a manner which potential users find relevant, requires additional time</p> <p>Difficult to accomplish since barriers in this class often lack a single focus</p>

SECTION IV

POTENTIAL RESULTS OF SOLAR ENERGY POLICIES

The major objective of encouraging use of solar energy through public policies is to displace some fraction of the energy now provided in the form of fossil fuels, particularly gas in the case of Project SAGE. If current projections of the energy future prove accurate, the displacement will eventually take place with or without policies to encourage it; however, the process is likely to take longer than is consistent with national objectives if there are no policy incentives.

While it is not possible to quantify the effect of an active dissemination program for solar technology information, it is reasonable to suppose that it would speed the evolution of a truly commercial solar industry. Once the industry is established, the price of solar collectors (the most expensive and technically risky element of a solar energy system) may decline dramatically and tip the economic balance in favor of solar energy (especially if fossil fuels continue to advance in price as expected). However, the development of the necessary large demand is hindered by the current high price due to the low level of demand. The objective of a program of policy incentives is to break this vicious circle and prime the pump of demand by artificial (i.e., non-market) forces.

Studies by JPL indicate that a collector price of \$3/ft² (in 1974 dollars, FOB the factory) is reasonable for an efficient, advanced all-glass collector with selective absorber, given a production of several million square feet of collector per year. Adding installation costs and reasonable overhead and profit, the estimated equilibrium price of collectors could be something over \$5/ft². Collector area is the most important unknown in solar installation cost since it is currently uncertain and the largest cost over and above the cost of a conventional installation. The other elements of a solar installation (storage tanks, pumps, insulation, etc.) are current articles of commerce with well-defined costs.

A method has been developed at JPL for estimating the incentives necessary to bring collector costs from their current values down to the desired \$5/ft² for economic competitiveness at mass production. Some typical results are shown in Figure 4-1 for systems of varying collector area over the range required for single-family residential water and space heating to smaller multiple-family units.

The current installed price of solar collectors is roughly \$15/ft². From the curve it can be seen that incentives in the range of 35 to 55% on the total installed system cost can reduce that cost to the equivalent of the desired \$5/ft², simulating the effect of a mature solar industry. This provides a qualitative indication of the range of incentives necessary to bring about commercial production rates; as noted earlier, such incentives should be phased out as commercialization is achieved.

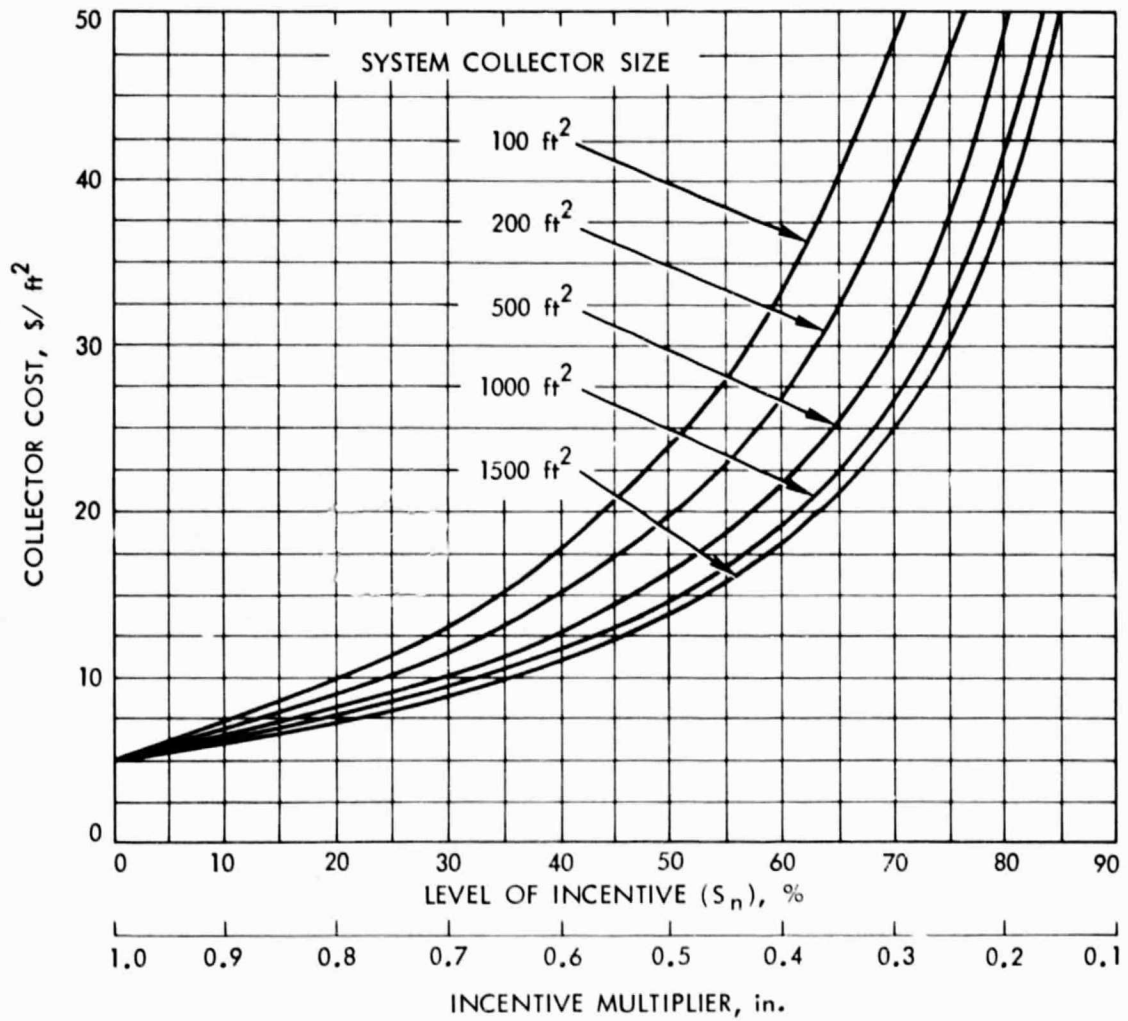


Figure 4-1. Collector Cost with Incentive Which is Equivalent to a \$5/ft² Collector with no Incentive for Solar Water Heating plus Space Heating

A second way of estimating reasonable incentive levels is to determine the conventional energy displacement effect of different incentive levels and select a level which seems optimal from the cost/benefit point of view. Figure 4-2 shows the results of this analysis, assuming no incentive, a 25% incentive, and a 50% incentive. The vertical scale (logarithmic) indicates the energy displaced by solar energy and total energy consumption (top dashed curve). The lower dashed curves are plotted to indicate the percentages of total energy.

This form of presentation enables us to determine the accelerating effect of the various incentives. For example, 10% of the total energy demand is displaced by solar in 1985 with a 50% incentive, by 1993 with a 25% incentive, and by 2000 with no incentive (intersections of the three solid curves with the 10% dashed curve). Thus the 50% incentive "buys" a 15 year earlier penetration to the 10% level and the 25% incentive a 7 year earlier penetration. Or, we see that in 1990 there is less than 1% displacement with no incentive, 8% with the 25% incentive, and 13% with the 50% incentive.

In practice, it will probably be most cost effective to use some combination of incentives, in effect an incentive "package" that would bring about the desired result at optimum cost. An analytical technique developed at JPL makes it possible to compute the effect of such combinations of tax incentives and low-interest loans and express the result as an equivalent percentage incentive. One interesting combination, for example, is a low-interest loan at 6% for 20 years plus a 25% tax credit. This provides the equivalent of a 50% tax incentive (assuming commercial interest rate of 10% and a rational consumer), but is probably more acceptable politically. The incentive package could be gradually scaled down by terminating the low-interest loan portion in 1980, reducing the tax incentive portion to 10% in 1985, and terminating the entire program in 1990. It could be expected that the prospect of reduction and termination of the incentives would provide a strong motive for early adoption of solar systems.

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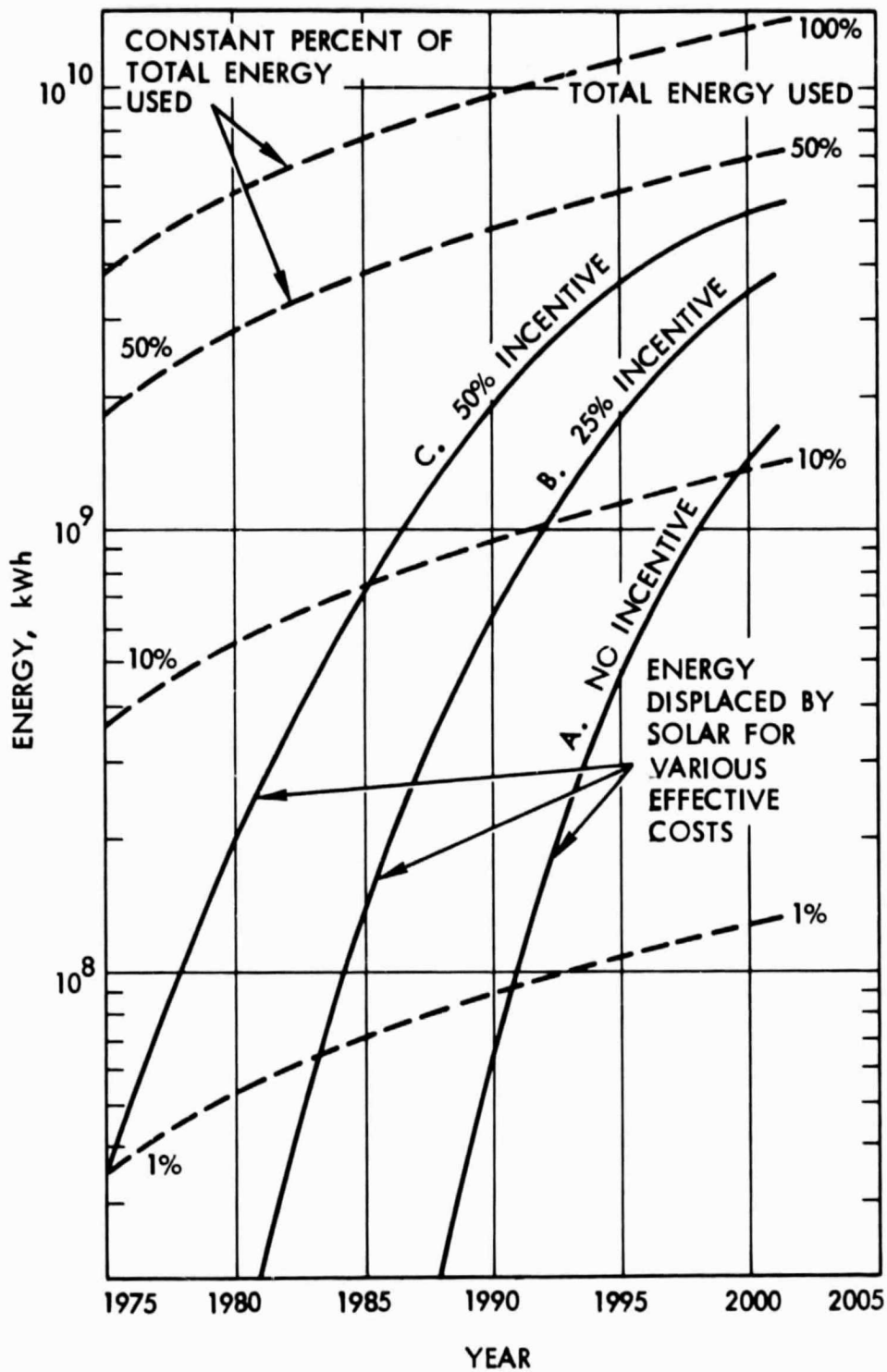


Figure 4-2. Energy Savings with Solar Space and Water Heating (Total Energy Figures Are for Southern California Market)

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